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Original research

Comparison of short-term outcomes after elective surgery following endoscopic stent insertion and emergency surgery for obstructive colorectal cancer

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ABSTRACT

Purpose: The aim of this study was to compare short-term morbidities and mortalities of elective surgery after stent insertion and emergency surgery in obstructive colorectal cancer.
Methods: We retrospectively reviewed 77 patients with obstructive colorectal cancer that underwent elective surgery after stenting (stent group: SG, $n = 49$) or emergent surgery (emergency group: EG, $n = 28$) from January 2000 to July 2010.
Results: The American Society of Anesthesiologists (ASA) score of SG was lower than that of EG ($p = 0.015$). The percentages of open and laparoscopic surgery in SG were 73.5% (36/49) and 26.5% (13/49), respectively, whereas surgery in EG was performed using an open technique ($p = 0.003$). The rate of primary anastomosis, without constructing a stoma, was 87.8% in SG and 42.9% in EG ($p < 0.001$). There was no difference in a postoperative complication. Anastomotic leakage according to time between stent placement and surgery in SG were 3 cases for 1–9 days and 0 for more than 10 days ($p = 0.037$). Three-year overall survival rates were 68.8% and 51.3% ($p = 0.430$), respectively.
Conclusion: Preoperative stent insertion in obstructive colorectal cancer seems to be safe and feasible, and may decrease second stage procedure. Waiting 10 days after stent placement may be a more optimal time for surgical intervention. Further prospective randomized studies are needed to determine the proper time bridge to surgery following stent insertion in obstructive colorectal cancer.

1. Introduction

The incidence of colorectal cancer continues to increase in Korea, and it now stands as the second most common cancer in men and the third most common in women; accounting for 15.2% and 10.6% of cancer cases, respectively.[1] Acute colorectal obstruction is usually caused by malignancy, and is encountered in 8–25% of colorectal cancer cases.[2,3]

Emergency surgery for obstructive colorectal cancer is associated with increased morbidity and mortality rates, especially in older patients or in those with a poor general condition.[4] The insertion of a stents in obstructive colorectal cancer allows patients to recover general condition, facilitates bowel decompression for elective surgery and one-stage procedures, avoids stoma formation, and reduces morbidity.[5–8] Patients fear multi-step surgery, and find a stoma embarrassing. In fact, only 60% of patients with a repairable stoma undergo stoma repair.[9,10] Few studies have compared elective surgery following stent insertion with an emergency operation for obstructive colorectal cancer, and no study has recommended a proper point in time for elective surgery after stent insertion. In this study, we evaluated clinical aspects and compared the short-term results of radical resection to identify an effective modality for the treatment of obstructive colorectal cancer.

2. Methods

Seventy-seven patients underwent surgery for obstructive colorectal cancer at a single center from January 2000 to July 2010. All patients with obstructive, but resectable left sided colon cancer, and we excluded patients with a bowel perforation, massive gastrointestinal hemorrhage, right colon cancer, and patients who had received only palliative colostomy. Forty-nine patients that underwent elective surgery after stent insertion (stent group; SG) and 28 patients that underwent an emergency operation for obstructive colorectal cancer (emergency group; EG) were retrospectively reviewed. Six patients with stent obstruction or migration underwent an emergency operation, but nonetheless, these patients were treated as members of the stent group according to the requirements of intent-to-treat

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analysis. The following parameters were analyzed: sex, age, body mass index (BMI), American Society of Anesthesiologists (ASA) scores, preoperative carcinoembryonic antigen (CEA), underlying disease, tumor location, type of operation, operation time, cancer stage, number of harvested lymph nodes, postoperative complications, postoperative hospital stay, and mortality within one month of surgery. We defined postoperative ileus as an ileus pattern by abdominal radiography in patients who had fasted more than one week after surgery.

The majority of the patients in the emergency group underwent an emergency operation before 2004, because at that time, stent insertion for obstructive colorectal cancer had not been generalized in our hospital. Subsequently, we adopted elective surgery after stent insertion as a "bridge to surgery", if the patient did not have an economical problem and the medical team for stent insertion was available. Randomization was not an option, because it was not possible to assign a patient to SG if an emergency surgery is required under emergent circumstances.

Stent implantation was performed when patients showed obstructive symptoms, such as, radiologic evidence of abdominal distension with colonic dilatation. The stent used were self-expanding Nitinol stents (Taewoong Medical Co., Seoul) 4 cm longer than the lesion. Stents were inserted using a double-channel endoscope (GIF-2T 240, Olympus Optical Co. Ltd., Tokyo) or a colonoscope (CF Q240L, Olympus Optical Co. Ltd., Tokyo) under fluoroscopy using the through-the-scope method. A 0.035-inch guide wire (Zebra, Microvasive, USA) was introduced through the stenosis and beyond the obstruction. After removing the guide wire, water-soluble contrast was injected via a catheter to assess the length of the lesion, and the stent delivery catheter was introduced via the working channel of the colonoscope. The guide wire was then re-inserted, and a stent was placed using the delivery system. We removed the outer sheath, and then the stent was fixed to the lesion by stent expansion.

Statistical analysis was performed using SPSS ver. 13.0 (SPSS; Chicago, IL) with univariate analysis. Categorical and ordinal variables were cross-tabulated and analyzed using Pearson's chi-square test and Fisher's exact test. Continuous variables were compared using the Student's *t*-test. *P* values of less than 0.05 were considered significant.

3. Results

Male patients was 63.3% ($n = 31$) in SG, and 75% ($n = 21$) in EG, and mean ages in SG and ED were 63.6 and 56.6 years, respectively ($p = 0.024$). Patients with associated disease were 30(61.2%) in SG, and 12(42.9%) in EG. BMI, CEA level, tumor location, and tumor stage, were similar in the two groups. Colorectal obstruction occurred in two patients in SG. A greater proportion of patients had a higher ASA score of III in EG (SG: $n = 6$, EG: $n = 10$, $p = 0.015$). Laparoscopic surgery was performed only in SG. The operation methods of SG were; total colectomy ($n = 2$), left hemicolectomy ($n = 10$), Hartmann's operation ($n = 6$), anterior resection ($n = 20$), and low anterior resection ($n = 11$). In EG, the number of total colectomy and Hartmann's operation were 12 and 16, respectively. One-staged operation rate were 87.8% ($n = 43$) in SG, 42.9% ($n = 12$) in EG ($p < 0.001$) (Table 1).

The mean number of harvested lymph nodes were 26.2 in SG and 37.7 in EG ($p = 0.048$), but both groups were more than enough according to the guidelines for an adequate cancer operation. No significant intergroup difference was found for operation time, gas passage, hospital stay, Hartman's procedure, or overall complication rate. Anastomosis site leakage were 3 cases in SG ($p = 0.297$), and postoperative ileus were 4 cases in EG ($p = 0.015$). No 30-day mortality occurred in SG. However, one mortality occurred in EG due to acute respiratory distress syndrome; his preoperative ASA score was III (Table 2).

The anastomosis leakage was in one case among patients that underwent elective surgery with less than a 10-day interval after stent insertion, but no leakage among those with ≥ a 10-day interval ($p = 0.037$) (Table 3).

The mean follow up was 38.7 months, and the overall survival rate at three years were 68.8% in SG and 51.3% in EG ($p = 0.430$) (Fig. 1).

4. Discussion

There is still controversy in the treatment of obstructed colon cancer. Primary excision of the tumor with formation of an end colostomy (Hartmann's procedure) has been conducted commonly. Some have represented subtotal or total colectomy with primary anastomosis is a safe procedure.[11]

However, some factors like thinned out bowel and debilitated patients make it difficult to conduct primary anastomosis. Patients with obstructive colon cancer have a morbidity of up to 50% and a mortality of 15~20% due to dehydration, electrolyte imbalance, concurrent diseases, infection, and sepsis.[2,4,12–15] Dohmoto et al. first conducted stent insertion in patients with obstructive colorectal cancer for palliative purposes.[16] Since the late 1990s, stent

Table 1
Demographics of patients in the stent group (SG) and the emergency group (EG).

		SG ($n = 49$)	EG ($n = 28$)	*p* Value
Sex (*n*, %)	M	31 (63.3)	21 (75.0)	0.290
	F	18 (36.7)	7 (25.0)	
Age (year, range)[a]		63.6 (43~85)	56.6 (22~78)	0.024
BMI (kg/m^2, range)[a]		22.4 (16.0~31.6)	22.6 (18.8~27.3)	0.812
ASA before surgery (*n*, %)	I	6 (12.2)	0	0.015
	II	37 (75.5)	18 (64.3)	
	III	6 (12.2)	10 (35.7)	
CEA ± SD		21.7 ± 60.6	32.5 ± 107.1	0.621
Underlying disease (*n*, %)		30 (61.2)	12 (42.9)	0.119
Stent-associated complication	Obstruction	5	–	
	Migration	1	–	
Tumor location (*n*, %)	Colon	34 (69.4)	21 (75.0)	0.600
	Rectum	15 (30.6)	7 (25.0)	
Surgery technique (*n*, %)	Open	36 (73.5)	28 (100)	0.003
	Laparoscopic	13 (26.5)	0	
Operation type	TC	2	12	< 0.001
	LHC	10	0	
	HP	6	16	
	AR	20	0	
	LAR	11	0	
Stoma construction (*n*, %)		6 (12.2)	16 (57.1)	< 0.001
TNM stage	I	2	0	0.687
	II	14	10	
	III	19	10	
	IV	14	8	

SG; stent group, EG; emergency group, SD; standard deviation, BMI; body mass index, ASA; American Society of Anesthesiologist, CEA; carcinoembryonic Antigen, TC; total colectomy, LHC; left hemicolectomy, HP; Hartmann's procedure, AR; anterior resection, LAR; low anterior resection.
[a] Mean.

Table 2
Postoperative outcomes in the stent group (SG) and the emergency group (EG).

	SG ($n = 49$)	EG ($n = 28$)	*p* Value
Operation time (min, range)[a]	263.3 (90~600)	235.4 (90~400)	0.308
Harvested lymph nodes (range)[a]	26.2 (4~70)	37.7 (9~104)	0.048
Gas passage (day, range)[a]	3.1 (1~7)	2.4 (1~5)	0.054
Diet (day, range)[a]	4.8 (2~8)	6.2 (3~12)	0.049
Postoperative hospital stay (day, range)[a]	12.1 (6~34)	15.1 (7~31)	0.109
Hospital stay (day, range)[a]	24.4 (9~59)	21.7 (9~59)	0.420
Hartmann reversal (*n*, %)	2 (33.3)	3 (18.8)	0.467
Postoperative complication (*n*, %)	8 (16.3)	7 (25.0)	0.355
Anastomotic leak[b]	3	0	0.297
Postoperative ileus	0	4	0.015
Atelectasis	1	1	0.685
Wound abscess	1	0	0.447
Intra-abdominal abscess	1	0	0.447
Voiding difficulty	1	0	0.447
Pseudomembranous colitis	1	0	0.447
Ureter injury	0	1	0.183
Intra-abdominal bleeding	0	1	0.183
Mortality	0	1	0.183

SG; stent group, EG; emergency group.
[a] Mean.
[b] Among 43 patients.

Table 3
Anastomotic leakage according to time between stent insertion and surgery in the stent group.

Interval following stent insertion (day)	Leak (%)	No leak (%)	*p* Value
1∼6	1 (20)	4 (80)	0.224
7≤	2 (5.3)	36 (94.7)	
1∼9	3 (20)	12 (80)	0.037
10≤	0	28 (100)	

SG; stent group, EG; emergency group.

insertion has been used as a primary management in patients with colorectal obstruction, because it offers the advantages of cost saving, enabling curative resection via a one-stage operation, and improving quality of life.[17]

The success rate of endoscopic stenting has been reported to be 75 ∼ 100%.[10,18] Its main complications are intestinal perforation, stent displacement, stent stenosis, and other complications, such as, minor bleeding, tenesmus, and constipation.[19–22] Furthermore, intestinal perforation has been reported to occur in up to 5% and to be the most severe complication of endoscopic stenting.[17,23]

No stent insertion is conducted for rectal cancer located within 5 cm superiorly to the anal verge, because the stent itself may stimulate the anus and levator ani. In the present study, no patient with obstructive colorectal cancer located 5 cm above anal verge complained of tenesmus after stent insertion.

It is always difficult for surgeons to determine whether emergency surgery or stent insertion should be conducted in patients with obstructive colorectal cancer. Few prospective randomized studies have addressed this issue, and subject numbers have been limited (Table 4). Although no statistical significance was found in some of studies, enterostomy closure rate, complication rate, mortality rate, hospital stay, and ICU stay have generally been shown to be lower in stent insertion groups than in emergency surgery groups. Martinez et al. reported that one-stage curative resection was successful in 41.4% of all patients and in 84.6% of patients that underwent preoperative stent insertion, and concluded surgery after stent insertion was advantageous.[10] In addition, they also reported that enterostomy closure occurred in 15% of SG and in 59% of EG. In the present study, curative resection was successful via one-stage operation in 42.9% of EG and in 87.8% of SG, which concurs with the results of the previous studies. In addition, Hartmann's operation was performed in 12.2% of SG, and in 57.1% of EG. Thus, the proportion that underwent enterostomy closure, which is not preferred by patients, was lower among patients that underwent surgery after stent insertion ($p < 0.001$). Hartmann's reversal was performed in 33.3% of SG (2/6), and in 18.8% of EG.

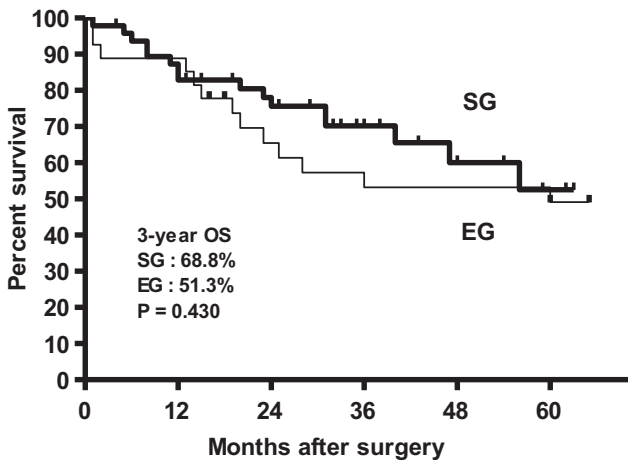

Fig. 1. Overall survival of stent group and emergency operation group. SG; stent group, EG; emergency group, OS; overall survival.

Ostomy-related complications account for much of the deterioration in quality of life. These complications have an incidence rate of approximately 34%, and include skin irritation with pain caused by inappropriate ostomy location, partial necrosis, prolapse, and stoma stenosis.[10] It has been reported that enterostomy closure is achieved in approximately 60% of patients who underwent ostoma procedure.[2] In this study, patients who underwent Hartmann's operation in EG were mainly old patients with concurrent diseases, and the rate of enterostomy closure was low as the patients refused secondary surgery. Total colectomy or Hartmann's operation was mainly conducted in EG. This was because primary anastomosis was avoided due to a poor systemic status, severe bowel edema, or ischemia of the colorectal wall, and because no appropriate intestinal preparation device was available in the operation room.

Important late complications of stent insertion include stent obstruction and stenosis due to tumor proliferation or stent displacement. These complications are caused by inappropriate stent selection, wrong positioning, and bowel movement, and can be reduced by using appropriate sized-stents and by exercising skill.[19,24,25] In the present study, five (10.2%) in the stent group experienced stent obstruction and one (2%) experienced stent displacement.

Preoperative stent insertion improves systemic status and enables intestinal cleaning by resolving intestinal obstruction, and thereby, improves hygienic status of the intestine, and reduces the risk of postoperative infection in patients with obstructive colorectal cancer. In addition, it enables preoperative examination of concurrent tumors of the proximal colorectum, resolves problems, such as, dehydration, electrolyte imbalance, ameliorates ischemic injury caused by a dilated intestine, and enables surgery to be conducted under the best conditions by allowing concurrent diseases to be assessed and treated before surgery.[18,26] In the present study, when systemic statuses were assessed before surgery, ASA score was found to be lower in SG than in EG ($p = 0.015$). In addition, open surgery was only performed in EG because it was difficult to secure the space required for laparoscopic surgery due to severe bowel dilatation. On the other hand, laparoscopic surgery was conducted on patients in SG because preoperative bowel cleaning and recovery of dilated intestine were achieved by stent insertion ($p = 0.003$). Laparoscopic surgery was known as a manner reminiscent of the faster recovery, less pain, and shorter hospitalization.[27,28]

Preoperative stent insertion has been reported to have the advantages of reducing postoperative complications and shortening total hospital stay and ICU stay.[10,29] In the present study, no intergroup difference was observed in terms of time to gas passage after surgery, and the times to diet after surgery were 4.8 days in SG and 6.2 days in EG, which was a significant difference ($p = 0.049$). Despite the aforementioned results, delay to diet in EG was probably due to a poorer systemic status in EG, and that ICU management was required to improve vital signs in this group.

Emergency surgery on patients with obstructive colorectal cancer has been reported to have a complication rate of 32 ∼ 62% and a mortality of 12.5 ∼ 26%.[2,3,9,23,30–36] In the present study, the complication rate in elective surgery following stent insertion was 16.3% as compared with 25.0% in EG, which was statistically insignificant ($p = 0.355$). Saida et al. reported a rate of anastomotic leakage of 3% in patients that underwent surgery after stent insertion and 11% in patients that underwent emergency surgery.[29] In the present study, the rate of anastomotic leakage was 7% in SG, which was slightly higher than in the previous study, but it

Table 4
Comparison of studies on colonic stenting versus emergency surgery for malignant colon obstruction.

Study	Design	Group	No	Age	Sex (M/F)	Tumor Location			Stoma	Cx	ICU stay	Hospital stay	RO	Mortality
	Year					D-colon	S-colon	Rectum						
Martinez et al[10]	RT	SG	43	71	26/17	11	18	14	4[a](12%)	17(40%)	0.3[a]	14.2[a]	0[a]	4(9%)
	2002	EG	29	74.6	15/14	10	15	4	17(54%)	18(62%)	2.9	18.5	5(17%)	7(24%)
Ng et al[23]	CMS	SG	20	74	17/3	3	7	10	1[a](5%)	6(22%)	0[a]	9[a]	1(5%)	1(5%)
	2006	EG	40	73.5	29/11	12	28	0	11(28%)	22(55%)	0.5	12	4(10%)	5(13%)
Ho et al[36]	PRT	SG	20	68	13/7	5	10	5	2(10%)	7(35%)	2	14	–	0
	2012	EG	19	65	9/10	8	8	3	6(32%)	11(58%)	3	13	–	3(16%)
Hooft et al[35]	PRT	SG	47	70.4	24/23	–	–	–	27(57%)	25(53%)	–	–	–	9(19%)
	2011	EG	51	71.4	27/24	–	–	–	34(67%)	23(45%)	–	–	–	9(18%)
Angenete et al[30]	RT	SG	112	73	57/55	92		20[a]	39(35%)	25(24%)	–	–	–	–
	2011	EG	60	73	28/32		57	3	60(53%)	20(33%)	–	–	–	–
Law et al[31]	RT	SG	30	75	20/10	2	10	18[a]	4[a](13%)	7(23%)	–	4[a]	–	4(13%)
	2003	EG	31	70	20/11	9	16	6	15(48%)	10(32%)	–	8	–	8(26%)
Carne et al[32]	RT	SG	25	66	13/12	4	12	9	2[a](8%)	6(24%)	–	4[a]	–	1(4%)
	2004	EG	19	68	12/7	2	6	11	12(63%)	9(36%)	–	10.4	–	3(16%)
Dastur et al[33]	RT	SG	19	75	10/9	2	12	5	5(26%)	–	–	4	–	1(9%)
	2008	EG	23	68	14/9	8	14	1	12(52%)	–	–	16	–	3(13%)
Guo et al[34]	RT	SG	34	77	19/15	9	19	6	7[a](21%)	8(24%)	–	19	–	1[a](3%)
	2011	EG	58	76	28/30	13	34	11	31(52%)	23(40%)	–	14	–	11(19%)

SG; stent group, EG; emergency group, Cx; complication, RO; reoperation, RT; retrospective trial, CMP; case-matched study, RPT; randomized prospective trial.
[a] p Value is lower than 0.05 for SG versus EG.

included the cases of suspected anastomotic leakage. These patients were treated conservatively, for example, by fasting and administering antibiotics without re-laparotomy. Postoperative ileus was examined in patients that fasted for one or more weeks after surgery, and was found to be significantly higher in EG ($p = 0.015$). Hooft et al. and Ng et al. also reported that the rate of postoperative ileus was higher in EG, albeit without statistical significance.[23,35] In the present study, no death occurred among patients that underwent elective surgery. On the other hand, one patient (3.6%) succumbed to acute respiratory distress syndrome within 30 days of surgery in EG.

This study has limitations that warrant mention. First, statistical analyses of differences between the two groups were limited by small patient numbers. Second, the study is limited by its retrospective nature, and the treatment selection was determined based on considerations of patient status and by physician's judgment. However, because ethically, it is not possible to assign a patient to SG if an emergency surgery is required under emergent circumstances, randomization was not an option.

Usually, surgery is performed 1 ~ 2 weeks after stent insertion, and it has been reported that this time is appropriate for avoiding of stent-induced peritumor inflammation and adhesion.[37] Hooft et al. reported an interval of 5 ~ 14 days in a multicenter study, and found that the risk of anastomotic leakage increased due to insufficient intestinal decompression and recovery of systemic status when time from stent insertion to surgery was short.[35] Ho et al. reported a mean time from stent insertion to surgery of 10 days, and found that a time of 9 ~ 14 days was appropriate, and that the risk of surgery increased if this time was greater than 2 weeks.[36] Postoperative anastomotic leakage causes complications, such as, intra-abdominal infection and abscess formation, and even death in severe cases. In the present study, times of surgery were divided using cut offs of 1 week and 10 days after stent insertion, and it was found that postoperative anastomotic leakage occurred less frequently in patients that underwent surgery 10 days or more after stent insertion than in the patients who underwent surgery within 10 days of stent insertion ($p = 0.037$), which suggests that it is safer if curative surgery is conducted 10 days or more after stent insertion. However, considering the small number of the patients recruited and a lack of consideration of other factors that affect anastomotic leakage, further study is required.

In conclusion, in obstructive colorectal cancer, elective surgery after stent insertion seems to be safe, and may have enabled laparoscopic surgery to be conducted. In addition, as compared with emergency surgery, one-stage operation that does not require colostomy can be applied after stent insertion. And our findings suggest that is safer to conduct curative surgery 10 days or more after stent insertion to reduce risk of anastomotic leakage. A further large-scale, randomized, prospective study is required to determine the appropriate time to conduct the surgery after stent placement and to analyze the oncological safety of elective surgery after stent insertion in obstructive colorectal cancer.

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None.

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None.

Author contribution
Gil Jae Lee and Hyo Jun Kim contributed equally to this study.

Conflict of interest
Gil Jae Lee, Hyo Jun Kim, Jeong-Heum Baek, Won-Suk Lee, and Kwang An Kwon have no conflicts of interest or financial ties to disclose.

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